

# PATENT ABSTRACTS OF JAPAN

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(71)Applicant : TOYODA MACH WORKS LTD

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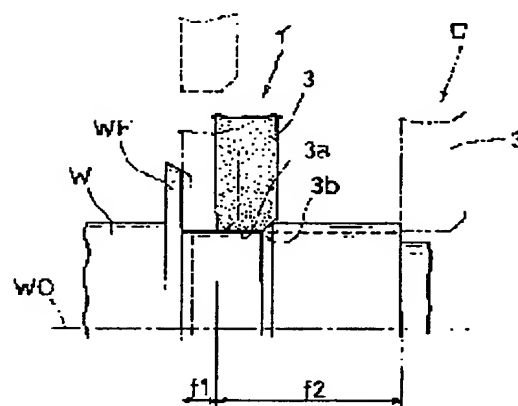
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## (54) GRINDING METHOD

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To prevent the shape sagging by performing the traverse grinding of a specified quantity where a grinding wheel surface is slightly separated from a work end surface at a slow speed hardly adding a grinding resistance, in traverse grinding stroke, and switching the speed to a normal high speed after the traverse grinding of the specified quantity to continue the traverse grinding.

**SOLUTION:** In traverse grinding stroke, traverse grinding is performed at a slow speed hardly adding a grinding resistance in a prescribed quantity  $f1$  where a grinding wheel surface is slightly separated from a work end surface. Since the work  $W$  is prevented from being warped at the start of traverse grinding, the circumferential side of the end surface of the flange part  $WF$  of the work  $W$  is never excessively ground, and shape sagging can be prevented. After the traverse grinding at the low speed of the specified distance  $f1$ , the traverse grinding is performed at a normal high speed in a distance  $f2$  from a speed switching position (a) to a traverse grinding complete position (b).



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CLAIMS

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[Claim(s)]

[Claim 1] It is the grinding approach characterized by for after the late rate which grinding force hardly requires, and traverse grinding of said specified quantity switching the specified quantity to which a grinding stone side estranges a work piece slightly from a work-piece end face in said traverse-grinding stroke in the approach of performing end-face grinding, plunge cutting, and traverse grinding to two steps of rates of the early rate of normal, and carrying out traverse grinding using a thin width-of-face grinding stone.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the approach of carrying out grinding of the cylindrical shape-like work piece at high speed using a thin width-of-face emery wheel smaller than the processing width of face of a work piece.

[0002]

[Description of the Prior Art] As an approach of carrying out grinding of the cylindrical shape-like work piece at high speed using a thin width-of-face emery wheel smaller than the processing width of face of a work piece, as drawing 5 shows The grinding stone 50 with which straight section 50a and inclined taper section 50b are prepared is used to the axis of rotation WO of a work piece W. As advance migration is made to carry out in the direction of a plunge which intersects perpendicularly with an axis of rotation WO to a work piece W and drawing 6 (a) shows a grinding stone 50 first, the end section of the flange WF of a work piece W It end-face grinding E Carries out in the edge section of straight section 50a of a grinding stone 50, and as drawing 6 (b) shows further, it plunge-cutting P Carries out and is processed to the desired diameter of finishing. Subsequently There is a method of moving a grinding stone 50 in the traverse direction parallel to the axis of rotation WO of a work piece W, traverse-grinding T Carrying out the peripheral face of a work piece W by taper section 50b and straight section 50a of a grinding stone 50, and performing the whole grinding process.

[0003] Since straight section 50a can perform [ taper section 50b of a grinding stone 50 ] rough grinding and perform finish grinding continuously in traverse-grinding T:00 according to this, cylindrical grinding can be performed by the one pass to a work piece W.

[0004]

[Problem(s) to be Solved by the Invention] when the initial speed of traverse-grinding T is quick, drawing 7 R> 7 shows the above-mentioned grinding cycle -- as -- the periphery side of the end face of a flange WF -- width of face of several micrometers -- a configuration -- whom -- t may occur

[0005] Grinding force is very small till termination of plunge-cutting P, it is the effect of this deflection, the end-face section contacts [ to there being almost no deflection of a work piece W since the traverse rate is quick, grinding force becomes large at the flash which traverse-grinding T starts, a deflection arises to a work piece W, ] the end face of a grinding stone 50, and this is because grinding is carried out.

[0006] the object of this invention -- the above-mentioned grinding cycle -- setting -- the periphery side of the work-piece end-face section -- a configuration -- it is offering the grinding approach whose took care to have not generated.

[0007]

[Means for Solving the Problem] It is characterized by for after the late rate which hardly requires grinding force, and traverse grinding of said specified quantity switching the specified quantity to which it is said traverse-grinding stroke and, as for the approach of this invention for attaining the above-mentioned object, a grinding stone side estranges a work piece slightly from a work-piece end face in the approach of performing end-face grinding, plunge cutting, and traverse grinding, using a thin width-of-face grinding stone to two steps of rates of the early rate of normal, and carrying out traverse grinding.

[0008]

[Embodiment of the Invention] The gestalt of operation of this invention is explained based on a drawing below. Drawing 1 shows the grinding process equipment with which this invention approach is enforced, 1 is the bed of grinding process equipment and the wheel spindle stock 2 is laid possible [ an attitude in the direction of X axis ] on this bed 1. The bearing of the grinding stone 3 is carried out to said wheel spindle

stock 2 pivotable. As drawing 2 shows this grinding stone 3, it is thin width of face, and it has the grinding stone layer of a diamond or a nature abrasive grain of superhard like CBN, and straight section 3a and inclined taper section 3b are prepared to the axis of rotation WO of a work piece W. 4 is a motor for a grinding stone revolution, and revolution actuation of the grinding stone 3 is carried out by this. 5 is the X-axis servo motor with which encoder 5a was connected, and carries out attitude delivery migration of said wheel spindle stock 2 in the direction of X axis.

[0009] By the Z-axis servo motor 9 by which encoder 9a was connected ahead of the wheel spindle stock 2 on said bed 1, the table 6 which moves to Z shaft orientations is laid, and a headstock 7 and tail stock 8 are counteracted and installed on this table 6. The work piece W which has a flange WF in main shaft center 7a of said headstock 7 and \*\*\*\* center 8a of tail stock 8 is supported, and revolution actuation is carried out by the main shaft drive motor built in the headstock 7.

[0010] 11 is numerical-control equipment which controls said grinding process equipment. This numerical-control equipment 11 consists of interfaces 16 which are connected with the interface 13 which connected with I/O device 14 equipped with the central processing unit 12, and the keyboard which performs an entry of data and the CRT display which performs the display of data, and has been connected with said central processing unit 12, the memory 15 linked to said central processing unit 12, and said central processing unit 12, and are connected with the motorised circuits 17 and 18.

[0011] The control data required to perform a processing program and a numerical-control program is memorized by said memory 15.

[0012] It connects with the X-axis servo motor 5, and encoder 5a of the X-axis servo motor 5 has connected one [ said ] motorised circuit 17 to said motorised circuit 17 and interface 16.

[0013] Moreover, it connects with the Z-axis servo motor 9, and encoder 9a of the Z-axis servo motor 9 has connected the motorised circuit 18 of another side to said motorised circuit 18 and interface 16.

[0014] By the absolute location of a headstock 7 and a table 6 being detected by encoder 9a connected with encoder 5a connected with said X-axis servo motor 5, and the Z-axis servo motor 9, a detecting signal is inputted into numerical-control equipment 11 while returning to the motorised circuits 17 and 18 and performing feedback control of a location.

[0015] Then, as the flow chart of drawing 3 shows the grinding process of the work piece W by said grinding stone 3 The advance migration of the grinding stone 3 is made to carry out it in the direction of a plunge which intersects perpendicularly with an axis of rotation WO to a work piece W as usual. It plunge-cutting P Carries out by end-face grinding E Carrying out the end section of the flange WF of a work piece W in the edge section of straight section 3a of a grinding stone 3, and is processed to the desired diameter of finishing. Subsequently traverse-grinding T Move a grinding stone 3 in the traverse direction parallel to the axis of rotation WO of a work piece W, by taper section 3b and straight section 3a of a grinding stone 3, carry out and perform the whole grinding process for the peripheral face of a work piece W.

[0016] By the way, in this invention approach, it is the stroke of traverse-grinding T and the activity of traverse-grinding T shown by drawing 4 differs with the conventional approach.

[0017] That is, in the flow chart of drawing 3 , a table 6 is positioned by the command of a grinding cycle in the processing location for the work-piece end-face grinding E (a grinding stone 3 is a dotted-line location at drawing 2 ). And revolution actuation is carried out and a grinding stone 3 and a work piece W carry out the grinding process of the end face of the flange WF of a work piece W by advance of a wheel spindle stock 2.

[0018] Then, a wheel spindle stock 2 moves forward to the location where grinding of the periphery of a work piece W is carried out to a predetermined finishing dimension, plunge-cutting P is performed, a table 6 traverses leftward [ of drawing 1 ] after completion of this plunge-cutting P, and it goes into the stroke of traverse-grinding T.

[0019] In the stroke of this traverse-grinding T, traverse grinding T1 of a late rate with which a grinding stone side hardly starts the specified quantity f1 slightly estranged from a work-piece end face as for grinding force is performed. since it is suppressed that a work piece W bends by this at the time of initiation of traverse-grinding T, the periphery side of the end face of the flange WF of a work piece W is deleted by the excess -- there is nothing -- the former -- like -- a configuration -- whom -- generating of t is inhibited.

[0020] In the distance f2 from rate switch location I to traverse-grinding completion location RO, it takes traverse-grinding T2 at the quick rate of normal after the traverse grinding T1 of the late rate of said specified quantity f1.

[0021] It is for example,  $5 \times 10^{-2} \leq f1 \leq 1$  [mm] extent, the quick traverse rates of normal are 75 mm/min, and the specified quantity f1 which said grinding stone side incidentally estranges slightly from a work-piece end face makes a late traverse rate late substantially like rate 10 mm/min.

[0022]

[Effect of the Invention] According to this invention, a work piece as mentioned above end-face grinding and when it carries out plunge cutting and goes into a traverse-grinding stroke The late rate hardly applied by grinding force carries out traverse grinding of the specified quantity which a grinding stone side estranges slightly from a work-piece end face. Since it is the grinding approach switched to two steps of rates which carry out traverse grinding of the traverse-grinding completion at the quick rate of normal after that since the grinding force of the flash which traverse grinding starts is reduced and the deflection of a work piece is suppressed by this at the time of initiation of traverse grinding, the periphery side of the end face of a work piece is deleted by the excess -- there is nothing -- a configuration -- whose generating can be prevented. And since the quick amounts of traverses of a rate are few, the effect on grinding efficiency can be suppressed to the minimum.

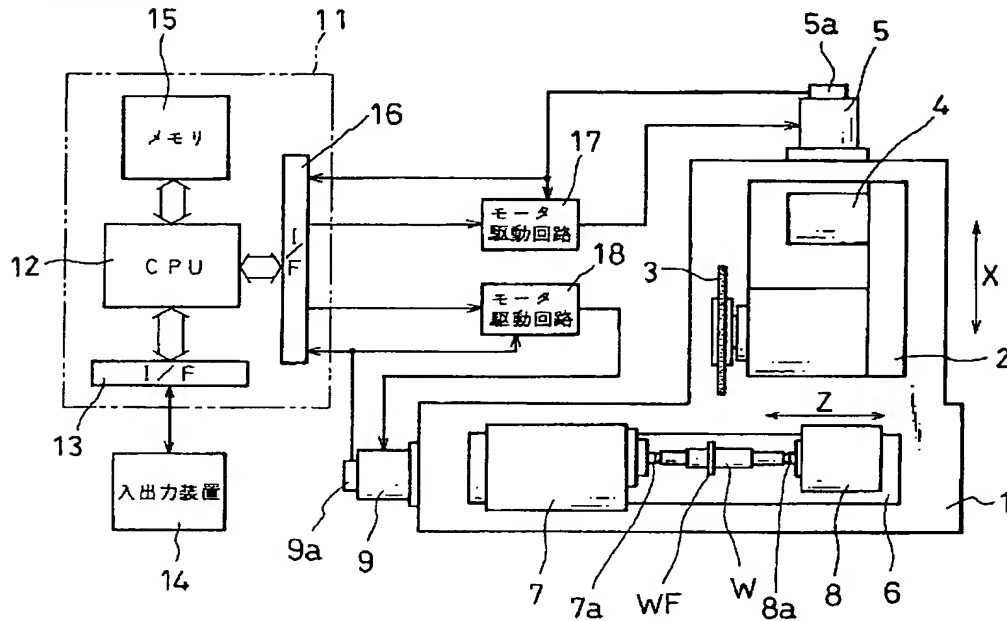
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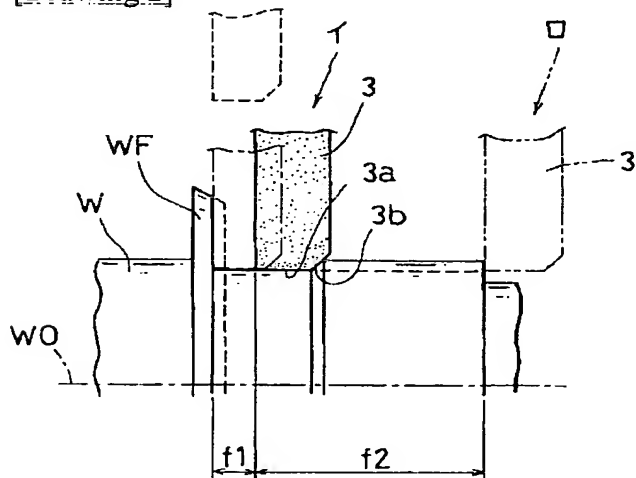
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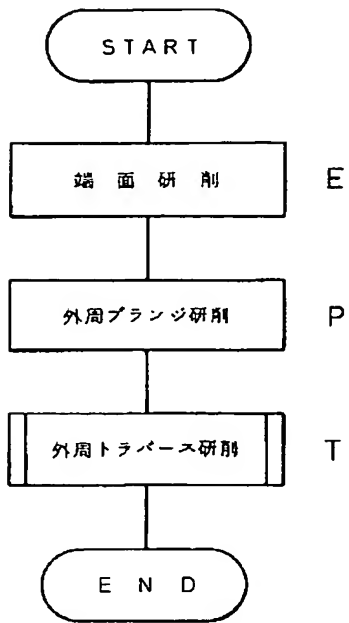
[Drawing 1]



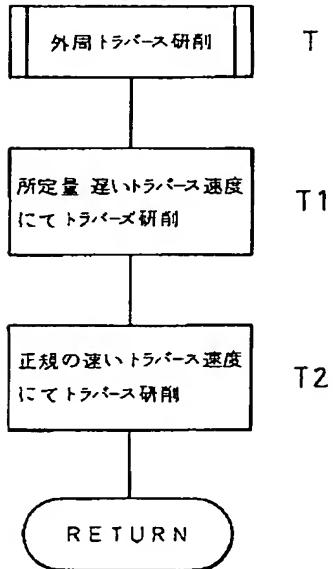
[Drawing 2]



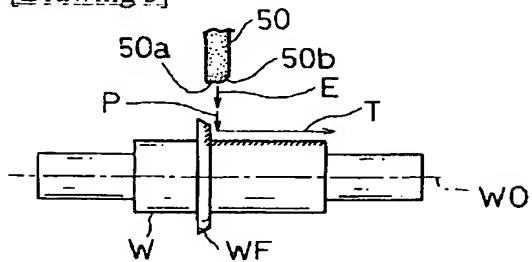
[Drawing 3]



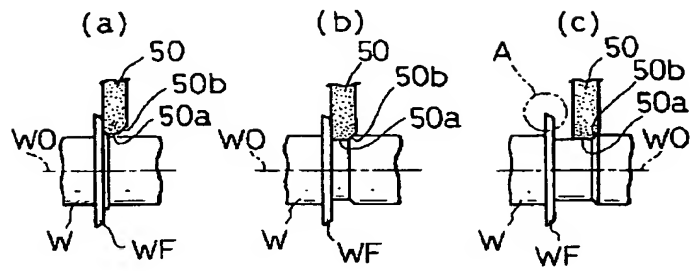
[Drawing 4]



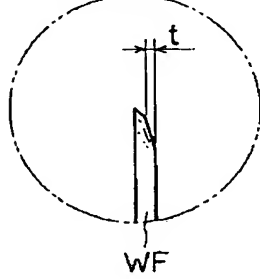
[Drawing 5]



[Drawing 6]



[Drawing 7]



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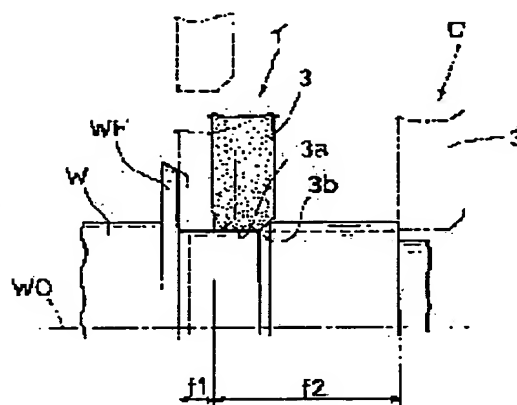
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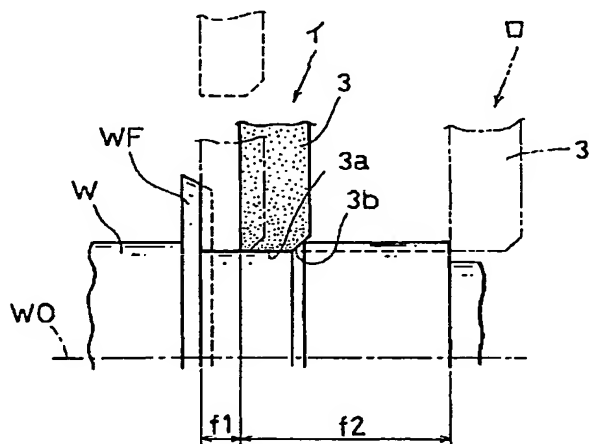
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## 【特許請求の範囲】

【請求項 1】 薄幅砥石を用いてワークを端面研削、ブランジ研削及びトラバース研削を行う方法において、前記トラバース研削行程で、砥石面がワーク端面から僅かに離間する所定量を殆ど研削抵抗のかからない遅い速度と、前記所定量のトラバース研削後は正規の早い速度の 2 段階の速度に切り換えてトラバース研削するようにしたことを特徴とする研削方法。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】本発明は、円筒形状のワークをワークの加工幅より小さい薄幅砥石車を用いて高速で研削する方法に関するものである。

## 【0002】

【従来の技術】円筒形状のワークをワークの加工幅より小さい薄幅砥石車を用いて高速で研削する方法として、図 5 で示すように、ワーク W の回転軸線 W O に対しストレート部 5 0 a と傾斜したテーパ部 5 0 b が設けられている砥石 5 0 を用い、先ず砥石 5 0 をワーク W に対し回転軸線 W O と直交するブランジ方向に進進移動させ、ワーク W のフランジ部 W F の一端部を図 6 (a) で示すように、砥石 5 0 のストレート部 5 0 a のエッジ部で端面研削 E し、さらに図 6 (b) で示すように、ブランジ研削 P して所望の仕上げ径まで加工し、次いで、砥石 5 0 をワーク W の回転軸線 W O と平行なトラバース方向に移動させてワーク W の外周面を砥石 5 0 のテーパ部 5 0 b とストレート部 5 0 a とによってトラバース研削 T して全体の研削加工を行う方法がある。

【0003】これによれば、トラバース研削 T 時に砥石 5 0 のテーパ部 5 0 b により粗研削を行い、続いてストレート部 5 0 a により仕上げ研削を行うことができるので、ワーク W に対して 1 バスで円筒研削を行うことができる。

## 【0004】

【発明が解決しようとする課題】上記の研削サイクルにおいて、トラバース研削 T の開始速度が遅い場合に、図 7 で示すように、フランジ部 W F の端面の外周側に数  $\mu$  m の幅で形状だれが発生することがある。

【0005】これは、ブランジ研削 P の終了時まで研削抵抗が極めて小さく、ワーク W のたわみが殆どないのに対し、トラバース速度が遅いためにトラバース研削 T が開始する瞬間に研削抵抗が大きくなって、ワーク W にたわみが生じて、このたわみの影響で、端面部が砥石 5 0 の端面に接触し、研削されるためである。

【0006】本発明の目的は、上記研削サイクルにおいて、ワーク端面部の外周側に形状だれが発生しないようにした研削方法を提供することである。

## 【0007】

【課題を解決するための手段】上記の目的を達成するための本発明の方法は、薄幅砥石を用いてワークを端面研

削、ブランジ研削及びトラバース研削を行う方法において、前記トラバース研削行程で、砥石面がワーク端面から僅かに離間する所定量を殆ど研削抵抗のかからない遅い速度と、前記所定量のトラバース研削後は正規の早い速度の 2 段階の速度に切り換えてトラバース研削するようにしたことを特徴とする。

## 【0008】

【発明の実施の形態】以下本発明の実施の形態を図面に基づいて説明する。図 1 は本発明方法が実施される研削加工装置を示し、1 は研削加工装置のベッドであり、このベッド 1 上には砥石台 2 が X 軸線方向に進退可能に載置されている。前記砥石台 2 には砥石 3 が回転可能に軸承されている。この砥石 3 は図 2 で示すように、薄幅であり、ダイヤモンド又は CBN のような超硬質砥粒の砥石層を備えており、ワーク W の回転軸線 W O に対しストレート部 3 a と傾斜したテーパ部 3 b が設けられている。4 は砥石回転用モータであり、これによって砥石 3 は回転駆動される。5 はエンコーダ 5 a が連結された X 軸サーボモータであり、前記砥石台 2 を X 軸線方向に進退送り移動する。

【0009】前記ベッド 1 上の砥石台 2 の前方にはエンコーダ 9 a が連結された Z 軸サーボモータ 9 によって Z 軸方向に移動するテーブル 6 が載置され、このテーブル 6 上には主軸台 7 と心押台 8 とが対向して設置されている。前記主軸台 7 の主軸センタ 7 a と心押台 8 の心押センタ 8 a とにフランジ部 W F を有するワーク W が支承され、主軸台 7 に内蔵されている主軸駆動モータによって回転駆動されるようになっている。

【0010】11 は前記研削加工装置を制御する数値制御装置である。この数値制御装置 11 は中央処理装置 12 と、データの入力を行うキーボード、データの表示を行う CRT 表示装置を備えている入出力装置 14 と接続され、かつ前記中央処理装置 12 と接続しているインタフェース 13 と、前記中央処理装置 12 と接続しているメモリ 15 と、前記中央処理装置 12 と接続され、かつモータ駆動回路 17、18 と接続されているインタフェース 16 とから構成されている。

【0011】前記メモリ 15 には、加工プログラム及び数値制御プログラムを実行するのに必要な制御データが記憶されている。

【0012】前記一方のモータ駆動回路 17 は X 軸サーボモータ 5 に接続されており、X 軸サーボモータ 5 のエンコーダ 5 a は前記モータ駆動回路 17 とインタフェース 16 に接続している。

【0013】また、他方のモータ駆動回路 18 は Z 軸サーボモータ 9 に接続されており、Z 軸サーボモータ 9 のエンコーダ 9 a は前記モータ駆動回路 18 とインタフェース 16 に接続している。

【0014】前記 X 軸サーボモータ 5 に連結されているエンコーダ 5 a と Z 軸サーボモータ 9 に連結されたエン

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コーダ9aによって主軸台7、テーブル6の絶対位置が検出されるようになっており、検出信号はモータ駆動回路17、18に帰還されて位置のフィードバック制御が行われると共に、数値制御装置11に入力される。

【0015】そこで、前記砥石3によるワークWの研削加工は図3のフローチャートで示すように、従来と同様に砥石3をワークWに対し回転軸線WOと直交するブランジ方向に前進移動させ、ワークWのフランジ部WFの一端部を砥石3のストレート部3aのエッジ部で端面研削Eし、ブランジ研削Pして所望の仕上げ径まで加工し、次いで、砥石3をワークWの回転軸線WOと平行なトラバース方向に移動させてワークWの外周面を砥石3のテーパ部3bとストレート部3aとによってトラバース研削Tして全体の研削加工を行うものである。

【0016】ところで、本発明方法においては、トラバース研削Tの行程で、図4で示すトラバース研削Tの動作内容が、従来の方法とは異にしている。

【0017】すなわち、図3のフローチャートにおいて研削サイクルの指令によりワーク端面研削Eのための加工位置（図2で砥石3が点線位置）にテーブル6が位置決めされる。そして、砥石3及びワークWが回転駆動され、砥石台2の前進によりワークWのフランジ部WFの端面を研削加工する。

【0018】続いて、ワークWの外周が所定の仕上げ寸法に研削される位置まで砥石台2が前進し、ブランジ研削Pを行い、このブランジ研削Pの完了後にテーブル6が図1の左方向にトラバースしてトラバース研削Tの行程に入る。

【0019】このトラバース研削Tの行程では、砥石面がワーク端面から僅かに離間する所定量f1を殆ど研削抵抗のかからない遅い速度のトラバース研削T1を行う。これによりワークWがトラバース研削Tの開始時にたわむことが抑えられるため、ワークWのフランジ部WFの端面の外周側が余分に削られることがなく、従来のように形状だれの発生を抑止するのである。

【0020】前記所定量f1の遅い速度のトラバース研削T1後においては、速度切り換え位置イからトラバース研削完了位置ロまでの距離f2では正規の速い速度にてトラバース研削T2する。

【0021】因みに前記砥石面がワーク端面から僅かに離間する所定量f1は、例えば、 $5 \times 10^{-2} \leq f1 \leq$

1 [mm] 程度であり、正規の速いトラバース速度は75 mm/minで、遅いトラバース速度は速度10 mm/minのように大幅に遅くする。

【0022】

【発明の効果】以上のように本発明によると、ワークを端面研削、ブランジ研削してトラバース研削行程に入ったときに、砥石面がワーク端面から僅かに離間する所定量を殆ど研削抵抗のかからない遅い速度のトラバース研削し、その後はトラバース研削完了までは正規の速い速度にてトラバース研削する2段階の速度に切り換えた研削方法であるから、トラバース研削が開始する瞬間の研削抵抗が低減され、これによりトラバース研削の開始時にワークのたわみが抑えられるため、ワークの端面の外周側が余分に削られることがなく、形状だれの発生が防止できる。しかも速度の速いトラバース量は僅かであるので、研削能率への影響を最少限に抑えることができる。

【図面の簡単な説明】

【図1】本発明方法が用いられる研削加工装置とその数値制御装置の平面図

【図2】本発明の研削方法を示す説明図

【図3】端面研削からトラバース研削までのフローチャート

【図4】トラバース研削の動作内容を示すフローチャート

【図5】従来の研削加工サイクルの説明図

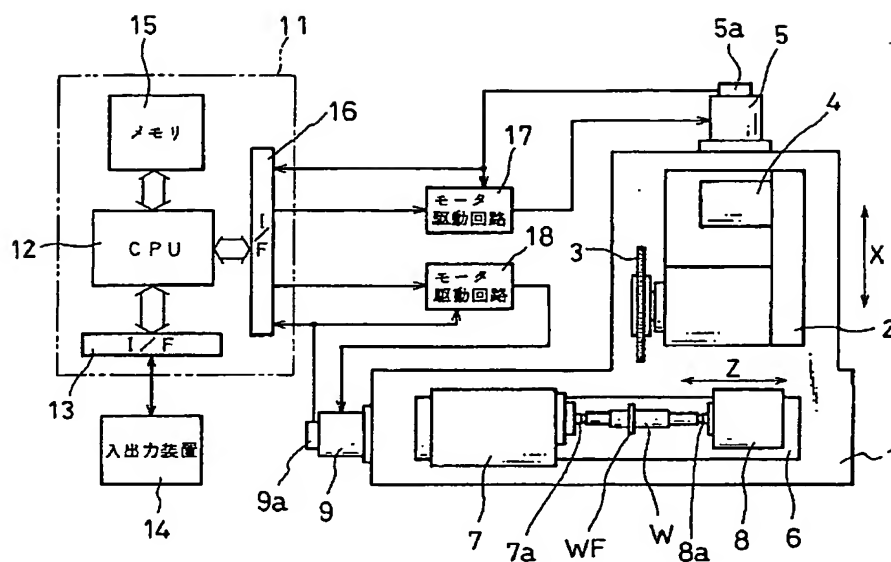
【図6】従来の研削研削状態を示す説明図

【図7】図6(c)のA部拡大図

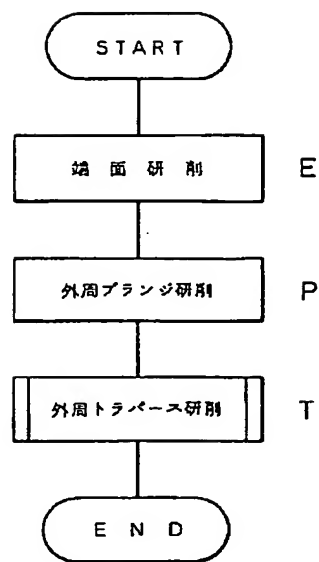
【符号の説明】

1	ベッド
2	砥石台
3	砥石
4	砥石回転用モータ
5	X軸サーボモータ
6	テーブル
7	主軸台
8	心押台
9	Z軸サーボモータ
11	数値制御装置
f1	遅い速度のトラバース研削を行う所定量
f2	速い速度のトラバース研削を行う距離

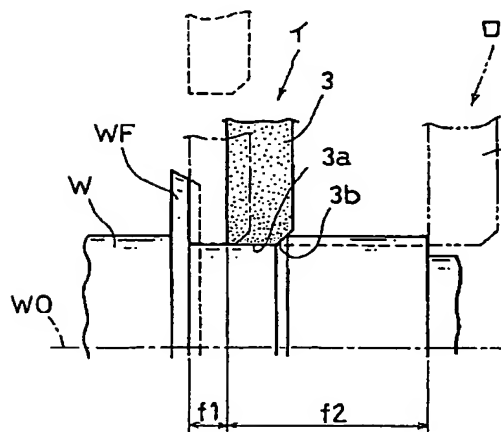
【図1】



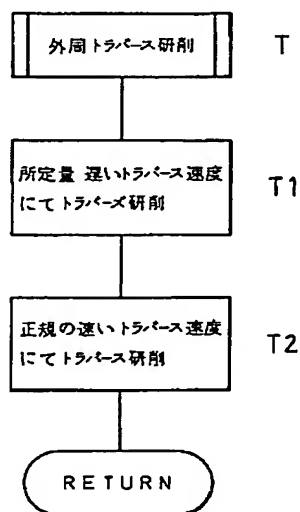
【図3】



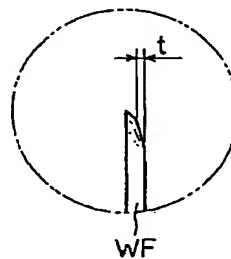
【図2】



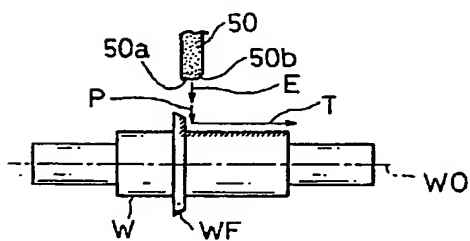
【図4】



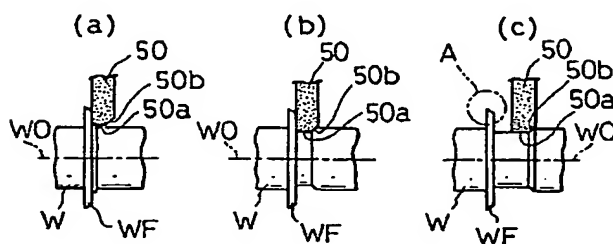
【図7】



【図5】



【図6】



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